Design and Validation of High Data Rate Ka-Band Software Defined Radio of Small Satellite

Completed Technology Project (2016 - 2017)

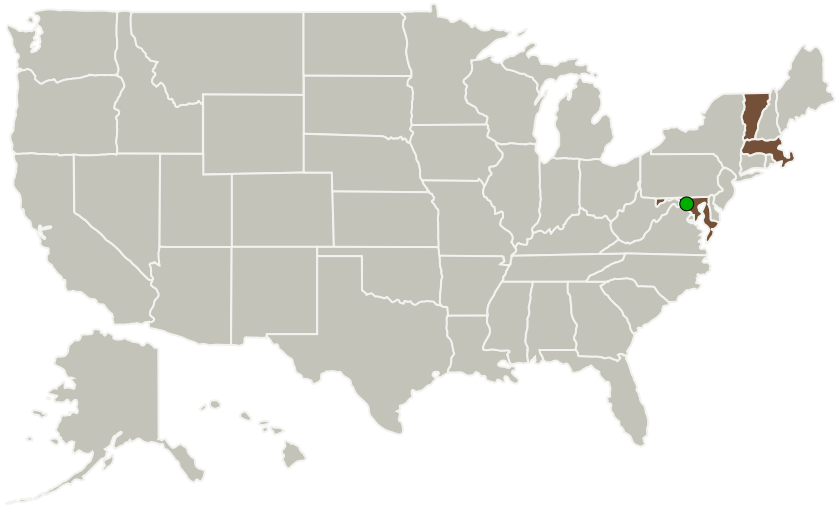
Project Introduction

This project develops a novel Ka-band transceiver circuit that is capable of establishing high data rate inter-satellite links with a throughput of 500 Mbps, and provide millimeter ranging precision. The system will be designed to operate with high performance and reliability that is robust against various interference effects and network anomalies.

Anticipated Benefits

The project will produce 3 products with infusion potentials. One is the SiGe RF front-end circuits, which can be licensed to RF device manufacturers. Secondly, the digital baseband SoC chip design, which can be prototyped through ASIC chip implementation to demonstrate its flexible performance. Both software and hardware systems are ready to be sold to satellite communication equipment companies. Finally, the ESA beam steering technique can be patented and licensed for advanced communication and tracking systems.

Primary U.S. Work Locations and Key Partners



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Organizations Performing Work	Role	Type	Location
University of Vermont	Lead Organization	Academia	Burlington, Vermont
Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland
Worcester Polytechnic Institute	Supporting Organization	Academia	Worcester, Massachusetts

Primary U.S. Work Locations	
Maryland	Massachusetts
Vermont	

Project Transitions

January 2016: Project Start

October 2017: Closed out

Closeout Summary: Communication system design demonstrated at PCB level, including the digital baseband and RF front end circuit, and signal processing alg orithms. The test results validates the design functionalities and received signal SNR > 50 dB. Completed the FPGA design and validation of the baseband proces sor with OQPSK modulator, LDPC decoder, frequency synchronization and timing recovery. Future work focuses on completing the design of the Ka-band transcei ver integrated circuit chip set. Publications: https://ntrs.nasa.gov/search.jsp?R= 20160007909 X. Cai, M. Zhou and X. Huang, "Model-Based Design for Software Defined Radio on an FPGA," IEEE Access, vol. 5, no. , pp. 8276-8283, 2017. X. Cai, M. Zhou, T. Xia, W. Fong, W-T Lee and X. Huang, "Baseband System Modeli ng and FPGA Design for Small Satellite Communications," IEEE Access, in revie w. M. Zhou, Y. Liu, T. Xia, and X. Huang, "An Efficient and Scalable Hardware Ar chitecture for Singular Value Decomposition towards Massive MIMO Communicat ions," Proceedings of the IEEE International Midwest Symposium on Circuits and Systems, August 2017. M. Zhou, X. Huang, Y. Zhou, X. Li, Y. Liu, "An FPGA Prot otype of Dual Link Algorithm for MIMO Interference Network," Proceedings of IE EE International Conference on Acoustic, Speech and Signal Processing (ICASS P), March 2017.

Organizational Responsibility

Responsible Mission Directorate:
Space Technology Mission Directorate (STMD)

Lead Organization:
University of Vermont

Responsible Program:
Small Spacecraft Technology

Project Management

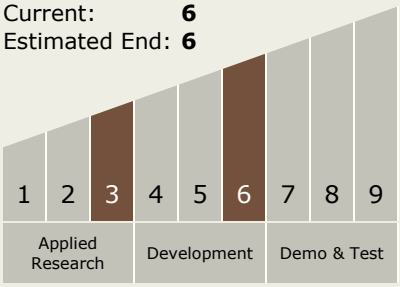
Program Director:
Christopher E Baker

Program Manager:
Roger Hunter

Principal Investigator:
Tian Xia

Technology Maturity (TRL)

Start: **3**
Current: **6**
Estimated End: **6**



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Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

Technology Areas

Primary:

- TX05 Communications, Navigation, and Orbital Debris Tracking and Characterization Systems
  - TX05.2 Radio Frequency

Target Destination

Earth